

# A Study about Cloud Computing Services in Smart Learning System

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**Abstract**—Cloud computing services offer several benefits in its implementation to e-learning system, such as increased cost savings and also improved efficiency and convenience of educational services. Furthermore, e-learning services can be also enhanced to be smarter and more efficient using context-aware technologies as context-aware services are based on the users behavior. To add those technologies into existing e-learning services, a service architecture model is needed to transform the existing e-learning environment, which is situation-aware, into the environment that understands context as well. The rationale behind this paper is to study the existence or lack of existing approaches regarding the implementation of cloud computing services in smart learning system. This is done by surveying the state of the art in the area, and illustrating the requirements of context-aware smart learning system with regard to some important factors: dynamicity, scalability, dependability, security and privacy. This paper is eager to help investigating the works that have been done before for cloud computing services in smart learning system and to show the possible requirements for the future smart learning system.

**Index Terms**—e-learning, smart learning services, cloud computing, context-aware, Internet enabled learning.

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## 1 INTRODUCTION

By the turn of the century, the fast development of digital technologies is creating not only new opportunities for our society but challenges to it as well. Our society is now being reshaped by rapid advances by technologies in the field of education, telecommunications, sciences and many more. Today, e-learning and cloud computing is emerging as the new-fangled paradigm of modern education with reduced upfront investment for teachers and the apprentices. E-learning is an Internet based learning process, using Internet technology to design, implement, select, manage, support and extend learning, which will not replace traditional educational methods, but will greatly improve the efficiency of higher education [1].

An increasing number of universities and educational institutions in the USA and UK are adopting cloud computing not only for increased cost savings but also for improving the efficiency and convenience of educational services. The cloud computing systems have been conducted for e-learning services. However, most of the current cloud-based education systems focus on delivering and sharing learning materials rather than supporting and establishing an integrated, total cloud-based educational service environment.

Both time spent on Facebook and time spent engaged in certain Facebook activities can be positively predictive, negatively predictive, or positively and negatively predictive of engagement, depending on the outcome variable. For example, time spent on Facebook is positively predictive of time spent in co-curricular activities while playing games on Facebook is negatively predictive. These results are congruent with others that have found that using the Internet and Facebook (Ellison et al., 2011) in certain ways leads to better psychosocial outcomes, and that using Twitter (Junco, Heiberger et al., 2010) in certain ways leads to better academic outcomes. Therefore, Facebook use in and of itself is not detrimental to academic outcomes, and can indeed be used in ways that are advantageous to students.

Higher education administrators, faculty and staff have an opportunity to help students use Facebook in ways that are beneficial to their engagement and, by extension, to their overall academic experience. Given that Facebook continues to be popular among college students, and that universities are interested in engaging and retaining students, it is important for those working in higher education to familiarize themselves with Facebook (and other such technologies) and to design and support interventions that meet students where they are in order to help them get to where they are going [2].

The rest of this review paper is organized as follows. Section 2 starts with general introduction into middleware. Section 3 illustrates the recent protocols and standards applied at middleware. Section 4 shows the categorization of middleware technologies according to the context of the study. Section 5 provides illustration for the main requirements of smart spaces with regard to middleware technology for services in ubiquitous computing. Section 6 gives some practices of current smart homes projects. Section 7 studies the middleware of SM4ALL and the rest of the practices described in section 6, according to the characteristics given in section 5. Section 8 describes the future directions of research work within the middleware for smart homes. Section 9 is the research conclusion.

## 2 E-LEARNING AND SMART LEARNING

There are several terminologies that refer to a learning environment with electronic devices, computers, or Internet. A study tried to investigate these terminologies when applied to some particular scenarios [3]. With 43 respondents involved in the survey, the result alleged that definitions found in various articles mirror the conflicting responses provided by the respondents in this study. The findings show great differences in the meaning of foundational terms that are used in the field, but also provide implications internationally for the referencing, sharing, and the collaboration of results detailed in varying research studies [3].

Traditionally e-learning offers teaching and learning by wired computers and in a lecture-style classroom setup only. Even though learners were able to browse and download information anytime and anywhere through the existing e-learning platform, they were limited to wired classroom setups. Then e-learning was developed further with the advancements of Internet. Thus, there are a number of cloud-based applications available in the e-learning sectors [4]. However, E-learning will not in any way replace traditional educational methods. Nevertheless, this will significantly improve the efficiency of the education [1].

Although e-learning is being used more intensively in recent years and some professionals have demonstrated a willingness to explore new approaches, many organizations still hold reservations about becoming involved with innovative pedagogical tools and have not yet realized what can be achieved with them. The range of possibilities offered by e-learning has not been fully exploited. For example, some organizations continue to limit their use of such tools to their repository functions, perhaps pushed to do so because of the poor IT skills of their employees. A research has shown e-learning impact on individual performance and the findings, the study has offered various sug-

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gestions to different communities of practitioners to improve their performance with regards to the adoption and continued use of e-learning [5].

The smart learning (s-learning) has become an important way of learning during the last few years [6]. It has been made possible by the recent advancements in the Mobile Internet and Information technologies. The S-learning has a major role in creating a good and personalized learning environment, and also being well adapted to the current education model wherever possible [7]. Usually, the teaching and learning that e-learning offers is only inside of a lecture-style classroom with desktop computers. Though the students could download information and browse through the existing e-learning platform regardless of time and place, they were still confined to the limits of the wired classroom-setups.

The concept of s-learning plays an important role in the creation of an efficient learning environment that offers personalized contents and easy adaptation to current education model. It also provides learners with a convenient communication environment and rich resources. However, the existing-learning infrastructure is still not complete. For example, it does not allocate necessary computing resources for s-learning system dynamically [6]. Currently, the majority of s-learning systems have difficulty in interfacing and sharing data with other systems, i.e., it falls short of systematic arrangement, digestion and absorption of the learning contents in other systems. This may lead to duplication in creating teaching resources and low utilization of existing resources. To resolve this problem, it is recommended to use cloud computing to support resource management.

So far there is no clear definition of Smart Learning. Related scholars and people who are involved with education business are discussing that the concept of Smart Learning should not be limited to just utilizing smart devices. Thus, the government, academia, and the educational industry have been working on defining and categorizing Smart Learning. At the Smart Learning Korea forum 2010 [9], a concept of Smart Learning was proposed as follows: first, it is focused on humans and content more than on devices; second, it is effective, intelligent tailored-learning based on advanced IT infrastructure [10]. Also, Kwak Duk-hoon, president and CEO of EBS (Korea's Educational Broadcasting System), said the term Smart Learning was first used in Korea. Then, what is the broad concept of Smart Learning in Korea? [8].

MEST (The Korean Ministry of Education, Science and Technology) defined Smart Learning as Self-directed, Motivated, Adaptive, Resource-enriched, and Technology-embedded [9]. More information on S.M.A.R.T Learning promoted by MEST is as follows:

- S: Self-Directed, which means that the education system is progressing toward a self-learning system more than ever. Students roles transition from knowledge adopters to knowledge creators. Also, teachers become facilitators of learning.
- M: Motivated means education becomes experience centered and involves learning by doing; creative problem solving and individualized assessment are pursued.
- A: Adaptive means strengthening of the education systems flexibility and tailoring learning for individual preference and future careers.
- R: Resource-enriched means that Smart Learning utilizes rich content based on open market, cloud education services from both public and private sectors. In other words, it expands the scope of learning resources to include collective intelligence, Social Learning.
- T: Technology-embedded means that in the Smart Learning education environment, students can learn anywhere, any time through advance technologies.

### 3 CLOUD COMPUTING AND EDUCATION

Electronic devices, especially computers, have been playing an important role in modern education since the emergence of e-learning. Education also has a close relation with the internet as many e-learning platform or system are based on online application. An example of popular e-learning that recently has been addressed a new form of on-line learning is Massive Open Online Course or MOOC for short [10]. Some example of these MOOC are edX<sup>1</sup>, Coursera<sup>2</sup>, and Udacity<sup>3</sup>. Several universities, such as MIT<sup>4</sup> and UC Berkeley<sup>5</sup>, also put their theaching materials ranging from undergraduate to graduate-level on-line, so that will be openly available and easy to access. A study asserted that openness and reputation are important for MOOC providers especially for course offering [11]. Openness and reputation are ways that MOOC providers can both differentiate themselves from competitors and enhance an individual's intention for continued MOOCs enrollment.

This section describes the close relation between cloud computing and educational subject, especially e-learning and s-learning. Cloud computing that introduces efficient scale mechanism can let construction of e-learning system be entrusted to suppliers and provide a new mode for e-learning [12].

#### 3.1 Necessity of Cloud Computing in Educational System

A study by Bouyer et al. alleged that Cloud computing is reducing the difference between on campus education and distance education still there are few limitations of E-learning for Lab based education due to computation power [13]. Fortunately cloud computing is the technology which can offer different services in three layers. Cloud computing enable students to access the knowledge by sharing distributed E-learning resources in a public, private or hybrid cloud systems. Due to using cloud computing system for deploying a modern educational systems, universities and other organizations must take to account various items such as cost and accelerate delivery of learning service, quickly learning, and privacy issue. Therefore, cloud service providers should especially attended to offering cloud-based learning for improving education status in poor countries in Asia and Africa.

Cloud computing also owns several important benefits for education [13]. Those important advantages are a quick delivery of various services, cost minimization, risk reduction, security enhancements, re-shaping teaching, and collaboration expansion.

#### 3.2 Cloud Computing and Smart Learning

The cloud computing is defined as a technology that provides its users with IT resources by using the Internet as a medium. The users can use IT resources such as application software or storage space from the cloud without needing to own them. The users only need to pay per usage charges for the resources they used. The concept of cloud computing is not new. It is the combination of distributed computing, grid computing, utility computing, etc. [3-5]. When a user requests services from some cloud server, the server immediately provides the requested services to the user based on their request details. It means that the cloud computing has the ability to customize its service to each user. Since servers charge fees based on usage, it can automatically guide its users of their service request based on previous usages. These features allow that users to use the service only the amount they need at their desired time. Also, there are numerous cloud based applications that are freely available and the trend for that continues to grow [6,7]. There are a number of cloud-based applications available in the e-learning sector as well [4].

Casquero et al. [8] presented a framework based on iGoogle and using the Google Apps infrastructure for the development of a network of cooperative personal learning environments. They discussed the integration of institutional and external services in order to provide cus-

<sup>1</sup><https://www.edx.org/>

<sup>2</sup><https://www.coursera.org/>

<sup>3</sup><https://www.udacity.com/><https://www.coursera.org/>

<sup>4</sup><http://ocw.mit.edu/>

<sup>5</sup><http://webcast.berkeley.edu/>

tomized support to faculty members in their daily activities. They also take advantage of the framework as a test-bed for the research, implementation and testing of their educational purpose services. Marenzi et al. [9] investigated how educational software can be used in an academic or corporate learning environment. They integrated models and tools that they developed into an open source environment for the creation, storage and exchange of learning objects as well as learning experiences. They presented the LearnWeb 2.0 infrastructure to support lifelong learning and to enhance the learning experience. This infrastructure brings together information stored on institutional servers, centralized repositories, learners desktops, and online communitysharing systems like Flickr and YouTube. Sedayao [10] proposed an online virtual computing lab that offers virtual computers equipped with numerous applications such as Matlab, Maple, SAS, and many others that can be remotely accessed from the Internet.

#### 4 CLOUD COMPUTING IN SMART LEARNING SYSTEM APPROACHES

There are several approaches of cloud computing. This study has reviewed several approaches of cloud computing in smart learning system. Some approaches that are

##### 4.1 Smart Cloud Computing

The Smart Cloud Computing (SCC for short) based on elastic computing for 4S model has the capability to provide a smart learning environment. It encourages learning system standardization and provides a means for managing it. A traditional e-learning system can display single content on a single device or multiple contents on one device. The SCC can deliver s-learning to the users so they can use multiple devices to render multi learning contents. The multi learning contents can be played in different devices separately to form a virtual class. For this, the SCC uses context-aware sensing. Sensing through the location and IP address of each device, it can orchestrate all devices. The architecture of the model is shown in the Figure 2 [4].

##### 4.2 Elastic Model

The smart learning (s-learning) has become an important way of learning during the last few years [6]. It has been made possible by the recent advancements in the Mobile Internet and Information technologies. The S-learning has a major role in creating a good and personalized learning environment, and also being well adapted to the current education model wherever possible [7]. Usually, the teaching and learning that e-learning offers is only inside of a lecture-style classroom with desktop computers. Though the students could download information and browse through the existing e-learning platform regardless of time and place, they were still confined to the limits of the wired classroom-setups.

##### 4.3 Context-aware

Context-aware is important [14].

Despite advances in mobile, interactive, and ubiquitous technology, the adoption of instructional technology and learning aids in traditional learning spaces has been lackluster. The system described in this paper is designed from the ground up to be affordable to implement, easy to operate, and most importantly, it is designed to keep the focus on the learning material by offering flexible and efficient learning interactions. It includes a cost-effective room-level location detection system based on IR light. This provides context awareness and allows the system to dynamically adapt based on its surroundings. Finally, the system provides efficient knowledge dissemination and sharing, and collaboration capabilities based on Semantic Web technology. It is designed to enhance traditional learning situations with modern instructional technology including handheld devices. The system has the potential to expand beyond indoor learning spaces through the use of mobile technology and other communication systems, thus providing a completely comprehensive learning experience [15].

#### 4.4 Ontology

The work of [16] has described this approach.

There have been many new advances in the computing field in recent times. Cloud Computing and Web 3.0 are two such areas that are beginning to significantly impact how we develop, deploy and use e-Learning application. Web 3.0 combines semantic Web with Web 2.0s tagging culture. It will use internet to make connections with information. Cloud Computing presents a new way of deploying applications. Today we can get Infrastructure as a Service (IaaS), Platform as a Service (PaaS) or Software as a Service (SaaS). There are elastic clouds where memory and processing power get allocated based on computing resources required at the time. Moreover, learning environment must be productive, scalable, flexible and adaptable towards learners needs and learner preferred information and communication technologies. This raises the question of whether cloud computing and web3.0 can meet the indicated requirements. To answer this question, Figure 2 introduces the proposed model with new technologies, integration between cloud computing and web 3.0.

In summary, the MONTO ontology fits very well into the general architecture of the Intelligent Tutoring Systems (pedagogy ontology to pedagogy module, Domain Ontology to expert module, task ontology to problem-solving environment, and student model ontology to student module) that can be considered as part of a smart learning environment. The MONTO ontology at the back-end is used for eight critical aspects (mentioned in The functionalities derived from ontology section) of the smart learning environment. It is concluded that the use of the MONTO-based system bridges the gaps highlighted in the state of the art study (See Fig. 14). A more effective implementation (constraint-free text entry, different way of presentation of schematic and semantic knowledge, inclusion of diagrammatic tool for drawing diagrams) would make the system more user-friendly. This ontology can also be used for drawing diagrams automatically for a given problem by using the problem schema. Those diagrams can be matched with the diagrams drawn by students to find missing concepts and misconceptions of the students. Using natural language processing (NLP) and machine learning (ML) techniques, one can generate problems similar to the problems being modeled in the ontology and create analytical questions for a given word problem that can be used in the pedagogy ontology. A completely functional system could use ML techniques to learn how problems are solved by good students and the same strategies could be taught to weak students. MONTO can be used as a part of a bigger adaptive smart learning environment to teach mathematics. With student profiles captured in MONTO, many more learning analytics can be generated for individual students and groups of students [17].

#### 4.5 Content Oriented

This paper proposed a content-oriented smart education system based on cloud computing that integrates a number of features required for implementing a cloud-based educational media service environment. The aim was to develop a total, integrated education content service system based on cloud computing to deliver and share a variety of enhanced forms of educational content, such as text, images, video, audio, animations, memos, quizzes, and 3D and AR objects. For the realization of a cloud-based content service system, we developed six main features. First, by leveraging several IT and cloud computing technologies, we established a private cloud platform to install and operate a cloud-based educational media service environment. In addition, we identified the software and applications required for the proposed cloud-based education services. Second, we developed a common file format enabling manipulation of various forms of media content on multiple platforms using XML, WebGL, and HTML5. Third, we implemented an authoring tool, allowing teachers to create various types of smart media content, including text, images, pictures, videos, and 3D and AR objects. Fourth, we developed a content viewer to display media content on diverse types of devices, such as PCs, notebooks, netbooks, tablets, smart TVs, and smartphones, through a multi-platform based design. Fifth, we implemented an inference engine to provide students with customized individual learning content

by analyzing their learning and content usage patterns. Sixth, a security system was included in the proposed system to encrypt data and to control user access for dependable smart media content services [18] [19].

## 5 DISCUSSION

This section draws the advantages and drawbacks of the reviewed works. This section will also reflect to the factors that drive a successful e-learning [20].

### 5.1 Advantages of Cloud Computing in Education

Some benefits are drawn based on [21].

- 5.1.1 A wealth of online application to support education
- 5.1.2 Flexible creation of learning environments
- 5.1.3 Support for mobile learning
- 5.1.4 Computing-intensive support for teaching, learning, and evaluation
- 5.1.5 Scalability of learning systems and applications
- 5.1.6 Costs saving in hardware
- 5.1.7 Cost saving in software

### 5.2 Drawbacks

## 6 CONCLUDING REMARKS

Smart Learning can be improved using smart cloud computing.

Since the main goal for this paper is to study whether the existing middleware practices at smart homes support the requirements of ubiquitous computing environments or not. This paper concludes that there are good smart homes infrastructures and practices e.g., SM4All and Gaia projects, that consider most of the basics of the ubiquitous computing needs (e.g., dynamicity, scalability, dependability, security and/or privacy). This done by first introducing the concept of middleware and its protocols and standards which are relevant for the projects e.g., UPnP and OSGi. Then, I classify middleware according to three types: object-oriented, service based, and object oriented base. Following this, a definition of requirements for smart spaces with regard to middleware technology are highlighted. These requirements are kept generic (e.g., dynamicity, dependability, scalability, security, and privacy) in order to allow the identification of criteria for the evaluation of middleware technology.

After that, I choose SM4ALL, RUNES, ANGEL, GTSH, Gaia, and Serenity as examples of the current practice middleware technologies projects at smart homes, discussing them with their comparisons for the middleware part according to the mentioned classification and the given ubiquitous requirements. The findings are that some projects touched the topics of dynamicity, scalability, and dependability at the middleware-service level. Also, a few of them filled the security and privacy needs. The only project that covers all defined requirements is SM4All.

However, the horizons of the present practices middleware will have to expand more and more to cater for the new requirements of ubiquitous computing (e.g., support of heterogeneity, mobility, tolerance for component failures, controlling and traceability, and ease of deployment and configuration) if they want to survive in the emerging smart space environments. This study help giving a look of the existing works of middleware at smart homes, and showing the requirements for the future vision. Moreover, it is not clear at this point exactly what smart space middleware will consist of. What is likely, however, is that various smart space architectures will emerge independently of each other which greatly increases the need for middleware to provide interoperability between heterogeneous systems.

This paper has compared and reviewed several researches and articles about cloud computing services in smart learning environment.

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